AL-1-1731
c.2

ROCK CHIPS

ALBERTA GEOLOGICAL SURVEY

Spring /Summer 2001

Vision: Alberta manages its abundant and diverse mineral resources to provide full opportunity for industry to explore and develop these resources for the greatest benefit to Albertans while ensuring commitment to sustainable development.

Aggregate Database in the Making

The Alberta Geological Survey (AGS) is a primary source of public information on sand and gravel deposits with potential as mineral aggregate. Most of the AGS aggregate information set was acquired under contract to government for use in resource management and planning. Information was subsequently released as AGS maps and reports. Between 1976 and 1983 the AGS program mapped sand and gravel resources at 1:50 000 scale detail and produced 2 Earth Sciences Reports, 5 Open File Reports and 87 Maps. This represents approximately 18 per cent of Alberta (Figure 1).

From 1984 to 1990 the AGS program mapped sand and gravel resources at 1:250 000 scale detail and produced 10 Open File Reports and 9 maps. These maps and reports cover a much greater area, accounting for about 35 per cent of Alberta (Figure 2).

Since the aggregate inventory at the AGS started producing information in 1976, a large variety of clients have been served and approximately 15 000 publications have been sold. Information in the aggregate data set is now quite old but is still in demand. In the last 5 years 1500 aggregate publications were sold and one of every aggregate

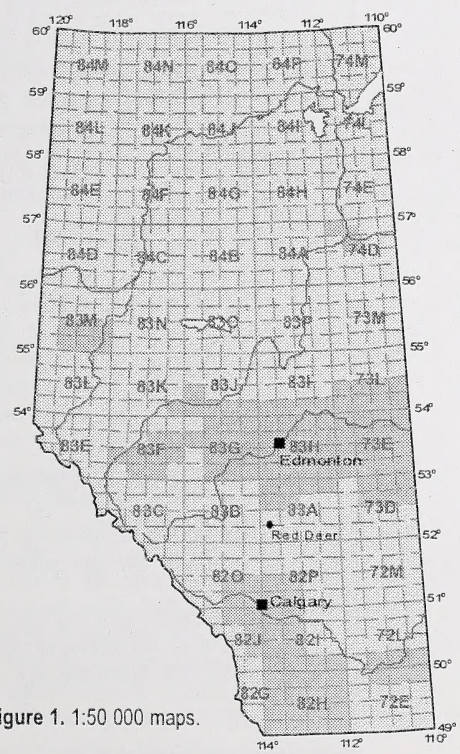


Figure 1. 1:50 000 maps.

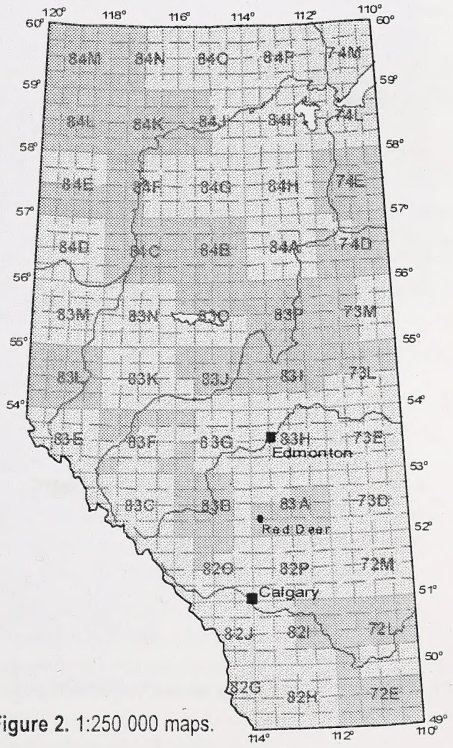


Figure 2. 1:250 000 maps.

EUB Alberta Energy and Utilities Board

AGS

publication (approximately 125 publications) was sold in the past 3 years. A recent change, however, is that the form of information now desired by most clients is as digital data.

In keeping with the continued demand for aggregate information and changing client needs, the AGS has embarked on a long-term, twofold plan. First, we will consolidate all existing deposit information in digital form and distribute this information as a CD-ROM with free ArcExplorer® software. We hope to have the complete data set available by April 2003. Second, we will complete sand and gravel mapping of the province at 1:250 000 scale detail (Figure 3). Deposit data from the new mapping will be incorporated into the CD-ROM as mapping proceeds. New mapping is slated to commence in 2002 or 2003 and finish in 2011. ❖

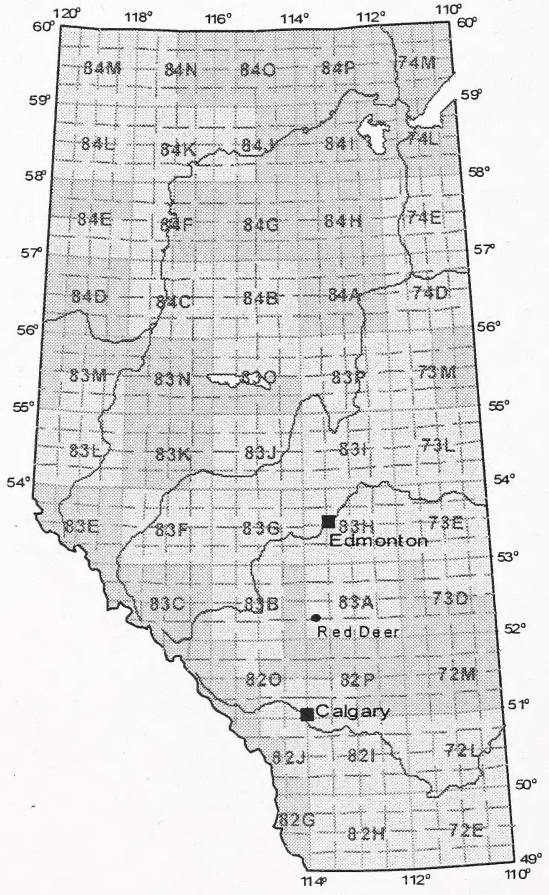


Figure 3. Sand and gravel mapping to be completed at 1:250 000 scale.

Rock Chips is published twice yearly by the Alberta Geological Survey, in the spring/summer and the fall/winter.

Individual articles, statistics, and other information in this publication may be reproduced or quoted without permission as long as the EUB/AGS is credited.

Past and present issues of *Rock Chips* may be viewed on the AGS Web site <www.ags.gov.ab.ca>.

To receive the paper version of *Rock Chips*, ask to be placed on our complimentary mailing list. Contact our Edmonton office by

e-mail:• <EUB.AGS-Infosales@gov.ab.ca>

- Facsimile: (780) 422-1918
- Telephone: (780) 422-3767

If you are currently receiving the paper edition and have a change of name or address, please forward corrections to one of the contacts above.

All AGS reports are available for purchase from the AGS Information Sales office in Edmonton. Orders may be placed in person or by phone, fax, or e-mail at the following address. Prepayment is required. We accept Visa/Mastercard, cheque or money order or a current EUB account number. GST is included in our prices.

Alberta Energy and Utilities Board
Alberta Geological Survey
Information Sales
4th Floor, Twin Atria Building
4999 - 98th Avenue
Edmonton, Alberta
Canada T6B 2X3
Phone: (780) 422-3767
Fax: (780) 422-1918
e-mail: <EUB.AGS-Infosales@gov.ab.ca>

Abstracts of most of our reports may be found on our Web site at **<www.ags.gov.ab.ca>**.

Clients in the Calgary area may view AGS publications at the Alberta Energy and Utilities Board Library, 640 - 5th Avenue SW.

Compilation of Structural Features in the Peace River Arch Region of Northern Alberta

Committed to economic diversification, the Alberta Government promotes awareness of Alberta's opportunities for exploration and mining of non-energy minerals, such as base and precious metals, gemstones and industrial minerals known to occur in the province.

Exploration for a wide range of mineral deposits is critically dependent on knowledge of the location and age of fractures, which may have acted as pathways and traps for mineralizing fluids and favoured kimberlite emplacement. As a first step to aid government and industry in their efforts to better target possible occurrences of non-energy minerals in the province, a regional compilation of the known and interpreted subsurface and surface structural features in the Peace River Arch region was recently initiated in northern Alberta.

The east-northeast trending subsurface geological structure, traditionally called the Peace River Arch (PRA), dominates the Phanerozoic geological evolution of northwestern Alberta.

As a first step to aid government and industry in their efforts to better target possible occurrences of non-energy minerals in the province, a regional compilation of the known and interpreted subsurface and surface structural features in the Peace River Arch region was recently initiated in northern Alberta.

The present digital compilation of structural features in the Peace River Arch area is an innovative approach in both handling and delivering geological information. The literature search resulted in a list of references that consists of approximately 300 titles of articles and abstracts and includes 19 Ph.D., M.Sc. and B.Sc. theses. Lineaments from various literature sources (digital and non-digital) were compiled digitally into ArcView® layers (i.e., shapefiles), individually tagged and linked to a Microsoft Access® database. The database includes attribute information for each line feature, such as reference, author's criteria for inferring a fault's existence, formation(s) affected, fault type, orientation of fault plane, and AGS comments. The shapefiles containing the compiled and inferred faults/lineaments and their attributes are distributed on a CD-ROM with the free ArcExplorer® software. In addition, the CD-ROM includes a comprehensive reference list arranged in chronological order from 1958 to 2000.

The digital format provides a flexible structure capable of incorporating additional information, and it allows various options for data selection based on such query criteria as location, timing, orientation and authorship. The product is envisioned as an open, flexible structure allowing for continuous updates and refinements. Time constraints required careful selection and prioritization of sources to be converted to GIS format. Consequently, the user should be aware that other structures have been described in the geological literature but have not yet been included in the database. At this stage the digital compilation includes a total of 518 faults captured from published isopach and structural maps for various stratigraphic intervals in the subsurface of northern Alberta. As well, it includes a total of 294 lineaments derived from facies and/or thickness changes that are depicted on maps in the *Geological Atlas of the Western Canada Sedimentary Basin*, areas tentatively interpreted by the authors to be structurally controlled, and a large number of lineaments derived from satellite images.

Users should keep in mind that faults, while represented as lines on a map, are frequently more zonal in nature. A fault plotted on a map as a line may in fact be a shear zone and/or fault zone on the order of several kilometres wide. The lineaments captured in this compilation are positioned with an accuracy of about the same order of magnitude as that of the original source materials. An example of appropriate use of the Peace River Arch compilation data might be that, where a fault or an intersection of faults can be inferred to have economic potential, this should be regarded as a zone of interest for further more focused investigation, not as an immediate drilling target.

In order to facilitate understanding of the geological significance of the compiled structural features, an accompanying digital report (PDF document on CD-ROM) provides an overview of the Late Proterozoic to Recent tectonostratigraphic evolution of northern Alberta. Aspects that may be relevant for both energy and non-energy minerals are addressed, with particular emphasis on exploration for sediment-hosted mineral deposits within each tectonostratigraphic phase.

This work may inspire further comprehensive multidisciplinary studies of relationships between tectonics and mineral occurrences. The rewards can be expected to be more than just academic, because energy and non-energy minerals are still waiting to be discovered and produced in Alberta.❖

Diamond and Metallic Mineral Potential of the Peerless Lake Map Area, North-Central Alberta

A regional geochemical sampling program for diamond and metallic-mineral potential was completed in the Peerless Lake map area, north-central Alberta (NTS 84B). The area encompasses the 1997 and subsequent discoveries of diamondiferous kimberlites by Ashton Mining of Canada Inc. and its co-joint venture partners, Alberta Energy Company Ltd. and Pure Gold Minerals Inc. The study is intended to provide reconnaissance-scale information from an area with known diamondiferous kimberlites.

The regional geochemical survey collected 184 samples, targeting a variety of sampling media: 88 stream-sediment heavy-mineral concentrates; 25 glaciofluvial or sand and gravel samples; 70 glacial-deposit (till, glaciolacustrine, diamicton, and B/C horizon transition) samples; and 1 preglacial sand and gravel sample. More than 2000 silicate and oxide grains were recovered and 1500 picked (definite and possible) silicate minerals were plotted, regardless of chemistry, to study their distribution relationships. In total, 606 grains were selected for quantitative analysis of major- and trace-element chemistry using an electron microprobe.

The spatial distribution of silicate diamond-indicator minerals, particularly peridotitic garnet and olivine, clearly shows four areas with elevated grain counts. Three anomalous areas occur in the northwestern and north-central parts of the map area, close to known kimberlite clusters (Figure 1). A fourth anomalous area, in the southwestern part of the NTS 84B map area, is characterized by a wide distribution of elevated grain counts. While glaciofluvial samples contain a large

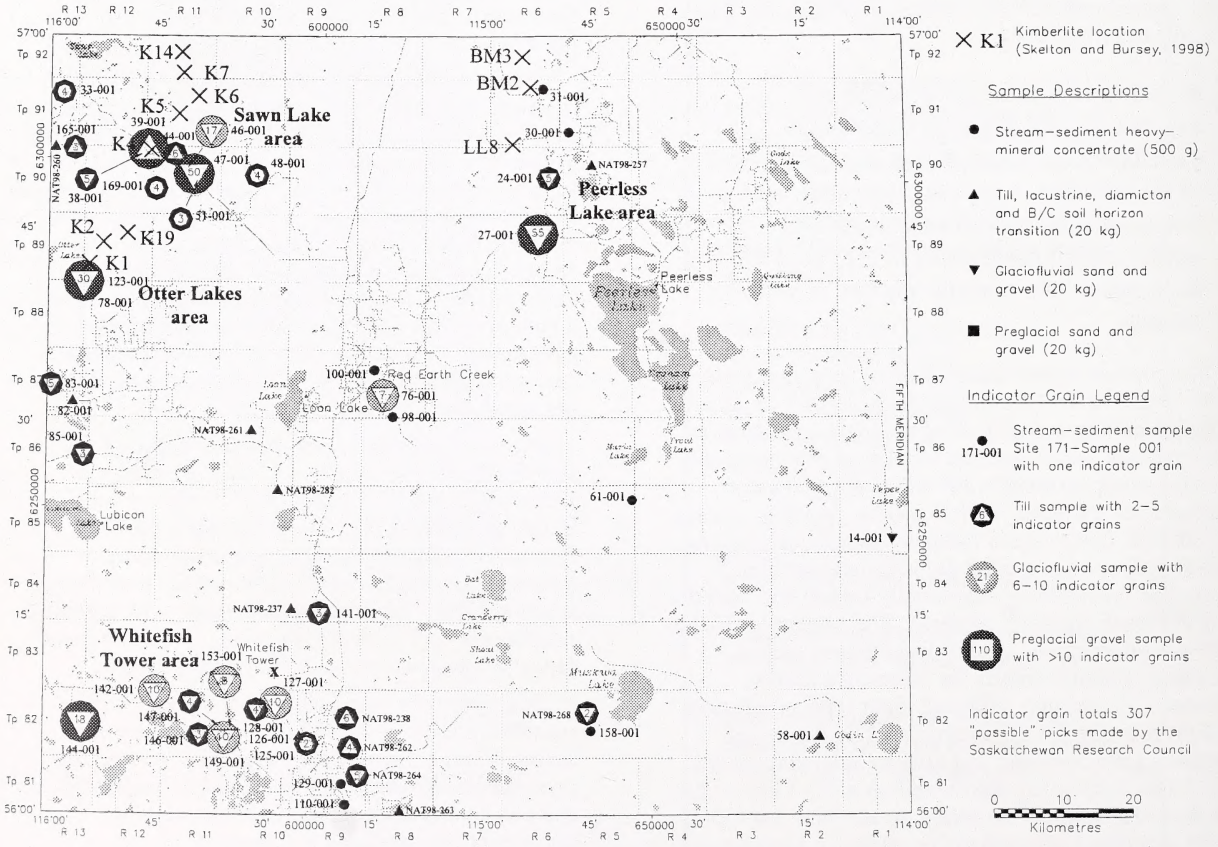
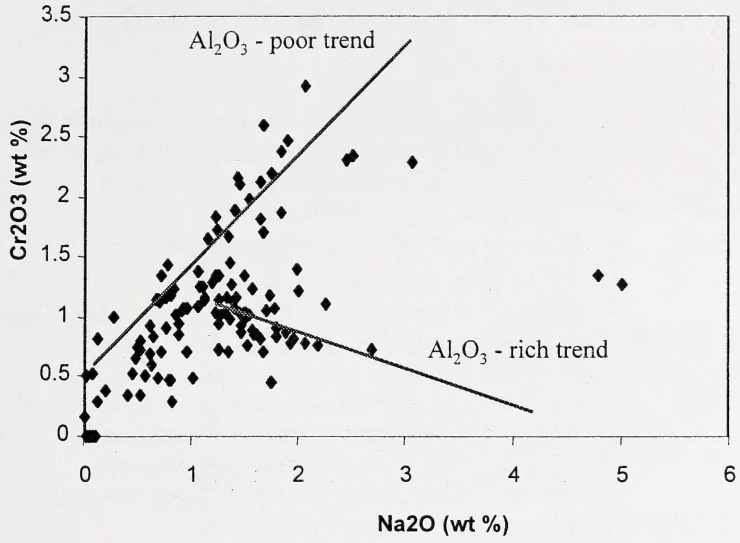


Figure 1. Spatial distribution of potential olivine grains. (A colour version of this map may be viewed on the AGS Web site <www.ags.gov.ab.ca>.)



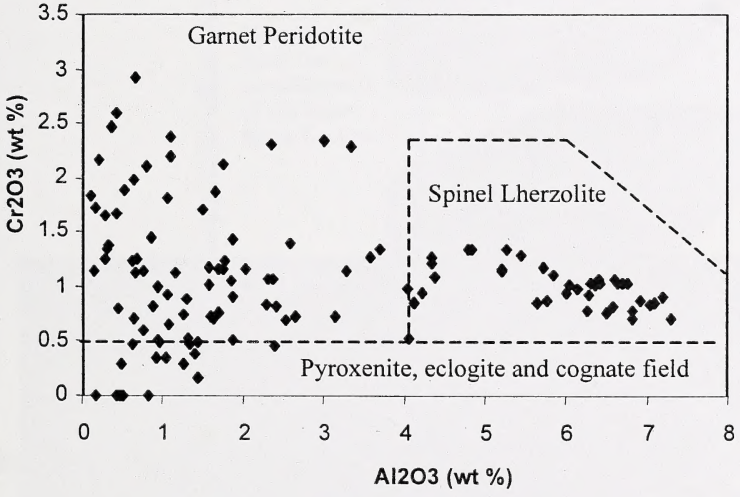


Figure 2. Scatter plots for selected clinopyroxene (chrome diopside) grains.

number of indicator minerals, high indicator mineral grain counts are generally independent of sample media. Heavy mineral sampling must, therefore, be recognized as a valuable exploration tool in other areas of Alberta that are similarly covered with complex surficial deposits of glacial origin.

> More than 2000 silicate and oxide grains were recovered and 1500 picked (definite and possible) silicate minerals were plotted, regardless of chemistry, to study their distribution relationships.

With few exceptions, all indicator mineral grains studied were derived from kimberlite. Based on the few samples analyzed, the sample mantle source is predominately lherzolitic, with minor harzburgitic and eclogitic/pyroxenitic constituents (see Figure 2).

The results of the geochemical survey show that the Peerless Lake map area in north-central Alberta has the potential for future discoveries.

The data in the current study represent one of the first regional indicator mineral studies near a known diamondiferous kimberlite cluster in Alberta. The information will benefit exploration companies as they develop sampling strategies in other parts of Alberta. The quantitative and qualitative trends of diamond indicator minerals from an area with known kimberlitic diatremes will enable better interpretation of possible indicator trains and future discoveries throughout Alberta.❖

Structural-Emplacement Model for Kimberlitic Diatremes in Northern Alberta

A study to evaluate structural controls on the Buffalo Head Hills kimberlites in the Peerless Lake area of north-central Alberta was initiated because of 1) the recognition of a set of north-trending lineaments that appear to be spatially correlated with the orientation of the Loon River lowlands; 2) irregularities in the Phanerozoic sedimentary cover; and 3) the emplacement of several kimberlitic diatremes. The combination of aeromagnetic and Radarsat imagery, draped on a digital-elevation model, clearly depicts the relationship between kimberlite intrusions and the intersection of north- and northeast-trending fault sets observed at surface (Figure 1).

A structural-emplacement model (Figure 2) has been constructed from new interpretations of data compiled for the Precambrian basement and Phanerozoic sedimentary rocks in the Peerless Lake area. The model shows that the emplacement of the Buffalo Head Hills kimberlites is consistent with worldwide examples in which kimberlite diatremes are associated with Phanerozoic grabens that result from the frequent transcurrent and/or extensional reactivation of a deep-seated mobile zone.

The model illustrates the upward propagation of basement structural events into the overlying sedimentary rocks. Doming or arching of the basement in the Peerless Lake area is geochronologically equivalent to the development of a Middle to Late Devonian half-graben. The asymmetry of the half-graben (called the Loon River Graben), coincides with the boundaries of the Loon River lowlands and is principally controlled by the location of three north-trending, steeply dipping, normal faults believed to sole out in the middle or lower crust. The geometry of the half-graben basin in the Peerless Lake area shows a series of tilted blocks that likely developed along faults paralleling a main border-fault system defined by the western edge of the Loon River Graben. The faults propagate through the entire Phanerozoic in the Peerless Lake area and provide important pathways for kimberlite emplacement.

This study shows that lineaments in surficial sediments or the underlying Cretaceous strata can direct exploration companies to tectonic zones in the Phanerozoic and basement and, therefore, to potential conduits for kimberlites and metalliferous hydrothermal systems. Furthermore, the structural features at the exposed surface of the Phanerozoic stratigraphic sequence reflect a complex tectonic history that extends as far back as the early Proterozoic. ❖

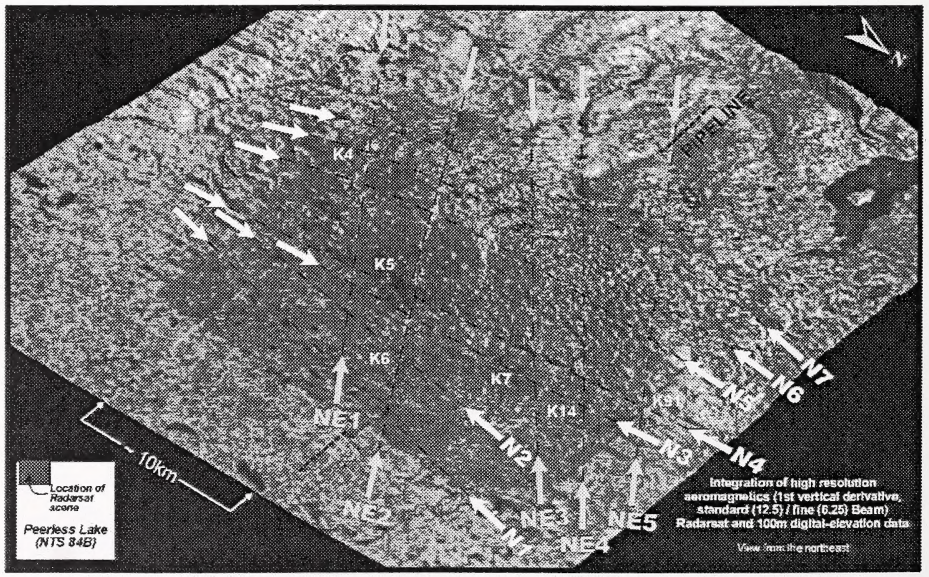


Figure 1. Integrated model of Radarsat, elevation data, and aeromagnetic data, showing transverse structural control on the Buffalo Head Hills kimberlites.

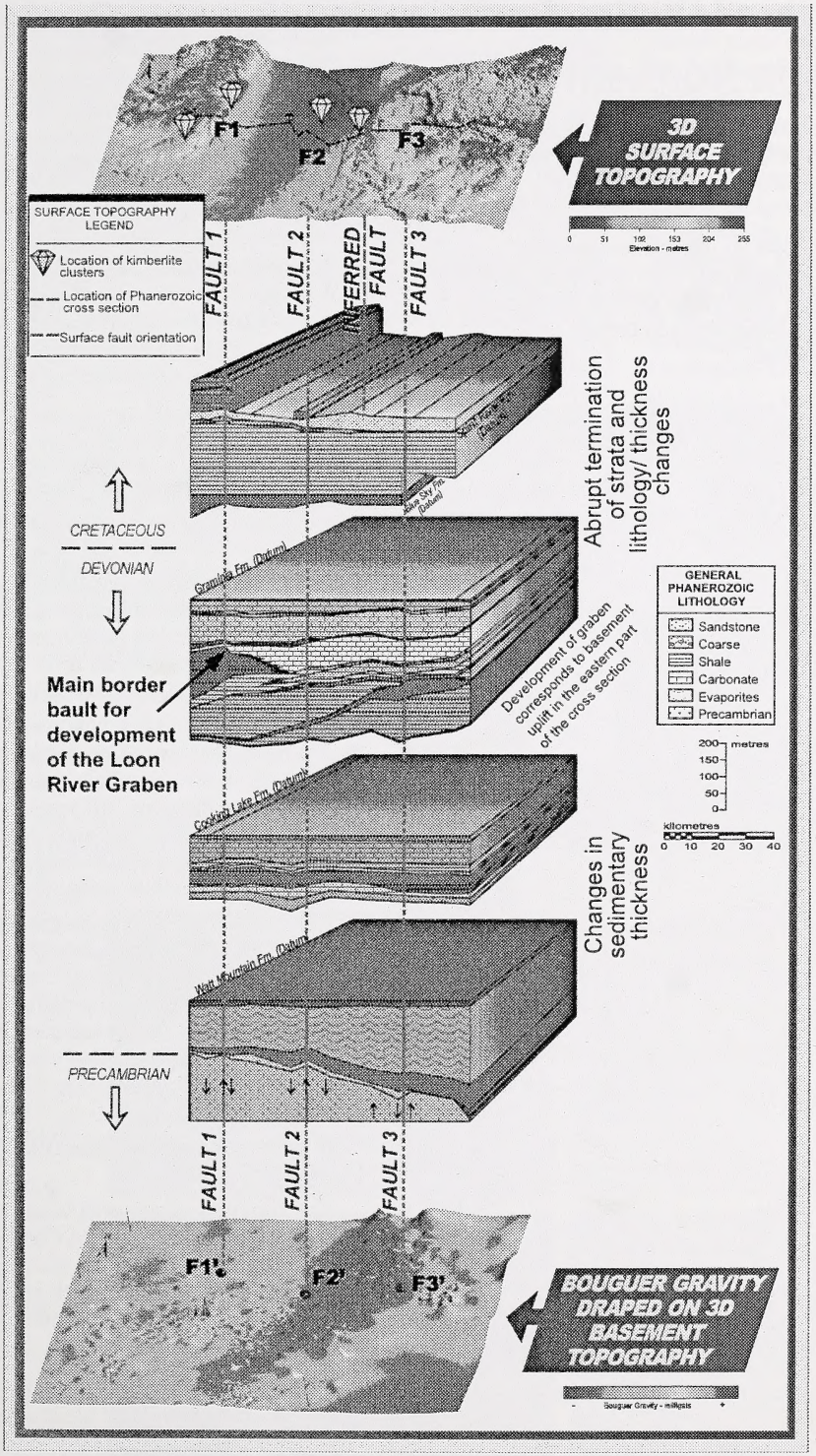


Figure 2. Structural-emplacement model for the Buffalo Head Hills kimberlites: basement, Phanerozoic, and surface.

Mineral Section Initiates Surficial Mapping and Quaternary Stratigraphy in Northern Alberta

April 2000 marked the start of a new multiyear program of the Minerals Section of the AGS focusing on the surficial mapping and Quaternary stratigraphy of northern Alberta.

There is little information on the surficial geology over much of northern Alberta and even less on the drift thickness and stratigraphy (Figure 1). Drift is all the unconsolidated sediment lying between the top of the bedrock and the land surface.

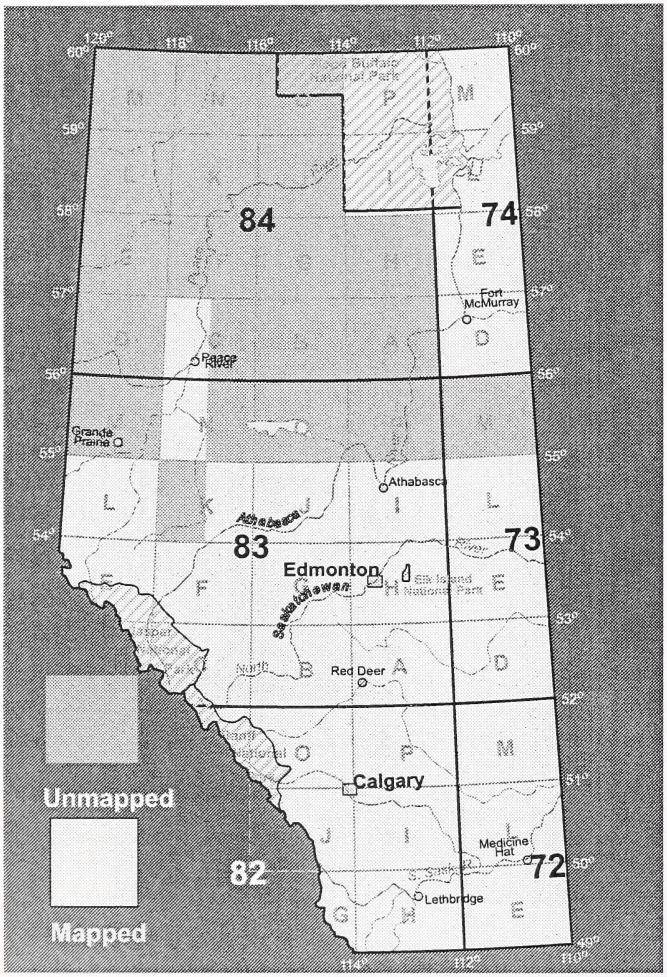


Figure 1. Extent of surficial geology mapping in northern Alberta.

Basic geological information on surficial geology, Quaternary stratigraphy, glacial history, and dispersal patterns is essential to mineral exploration and energy development in northern Alberta. These investigations may outline new areas of interest for mineral exploration. One of the Energy and Utilities Board strategic performance measures is to facilitate interest in mineral exploration by identifying and mapping geologically favourable areas for diamonds and industrial and metallic mineral deposits. Not only will these investigations provide basic Quaternary geological information but they may outline new areas of interest for mineral exploration.

Initially the Quaternary team included contributions from Mark Fenton, John Pawlowicz, Jill Weiss, Joan Waters, Monica Price, Dianne Goulet, and Dan Magee. During the year, Janet Campbell, another Quaternary geologist, was hired to complement the team.

The overall purpose is to provide baseline geological information in support of mineral and energy exploration and development in northern Alberta and information on drift stratigraphy, glacial history, iceflow, till geochemistry, and mineralogy.

All products from this study will be released in digital form, with provision for printed documents on demand. Activities will include airphoto interpretation, surface mapping, till sampling, drilling, lab analysis, and subsequently data synthesis and digital map preparation. Particular emphasis will be placed on making all activities more efficient and effective.

This year the focus was on the Pelican (83P) and Peerless Lake (84C) map areas (Figure 1). One technical highlight was the successful use of Palm Pilots in the field for on-site digital recording of all field data. This process saved considerable time, as the data could be uploaded to our databases quickly each evening. (See *Rock Chips,* Fall 2000, for an article on the Palm.)

This years preliminary scientific/geological highlights include:

- The discovery of a buried weathering surface in an auger core hole north of Calling Lake, which proves that the continental glaciers advanced over the region at least twice with an extensive nonglacial weathering interval between the two ice advances (Figure 2).

- Proving that Wiau buried channel (>140 m deep) extends northwest from Athabasca River into the Wabasca region, thus greatly extending distribution of the largest aquifer in Alberta. This aquifer already furnishes water for energy development in the Winefred region to the east.

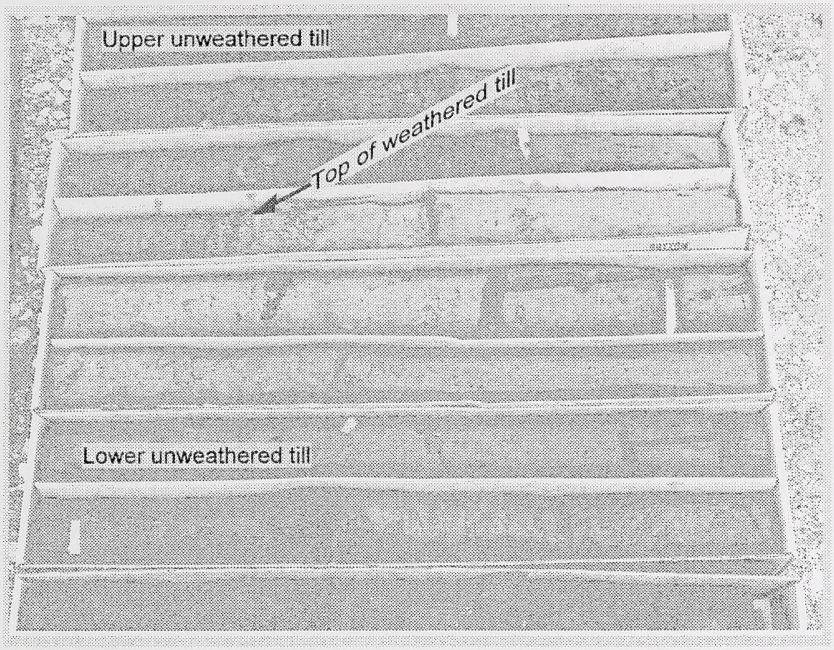


Figure 2. Buried oxidized or weathered till in core hole drilled from north of Calling Lake.

Products from this study will include a surficial geology map of the Pelican map area, bedrock topography and drift thickness maps of the Pelican and Peerless map areas, and short reports and/or data files on the core hole lithologs, surface sample sites, and geochemistry and diamond indicator mineralogy. Posters and presentations are planned for spring 2001 at the meetings of the Mineral Exploration Group (MEG), Geological Association of Canada (GAC) and Canadian Society of Petroleum Geology (CSPG) meetings.

Next year's activities will focus mainly on completing the Peerless map area and initiating work on the Algar map area (84A), with some final work on the Peerless Lake map area. This will include both surficial mapping and Quaternary stratigraphic studies.❖

- Glacial tills rich enough in bitumen to give off a distinctive odour discovered in new surface excavations and test holes in both the Pelican and Peerless study areas.

- Confirmation that there is an extensive cover of quartzite-rich gravel over most of the Pelican Mountains. This gravel is overlain by till in most places and is already being exploited in a number of areas for energy development infrastructure (roads, plant sites, etc.).

- Discovery of glacially crushed preglacial gravel in the Avenir pit southeast of Wandering River (Figure 3).

- Discovery that the Wapiti Formation extends farther southeast from the Pelican Mountains than previously known (Figure 4).

- The intersection of over 2 m of coal in an auger core hole drilled east of Hondo (Figures 5 and 6).

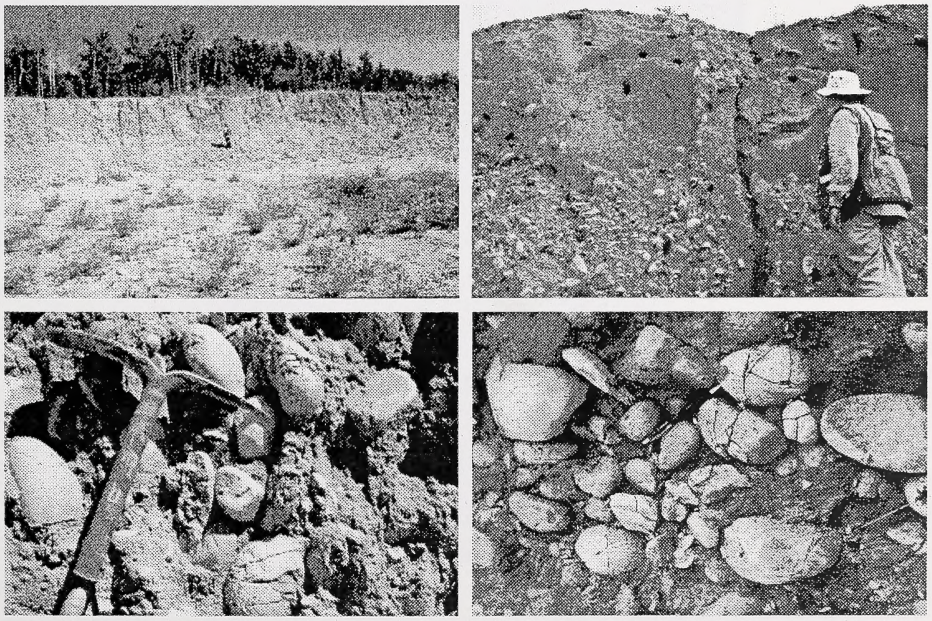


Figure 3. Quartzite gravel near Avenir. Stones have been deformed (cracked and crushed) by glacial ice.

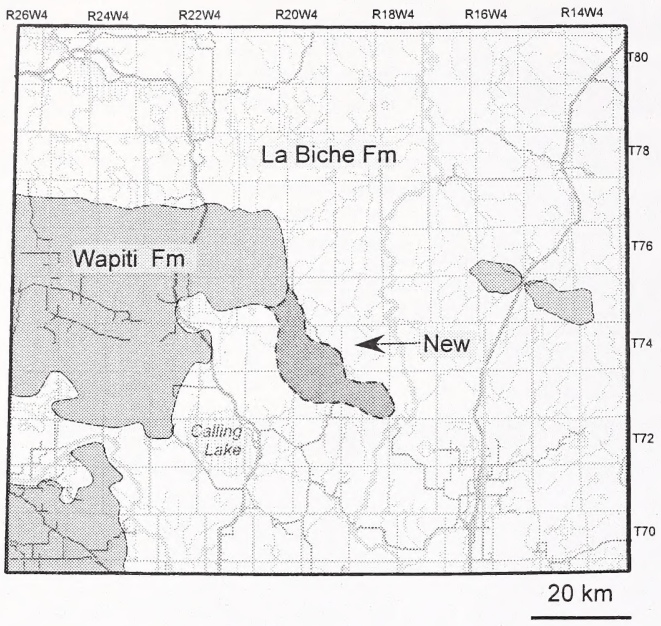


Figure 4. Map showing newly expanded distribution of the Wapiti Formation.

Figure 5. Drilling east of Hondo intersected coal at 4.8 m depth (1.2 m thick) and at 8.4 m deep (2.4 m thick).

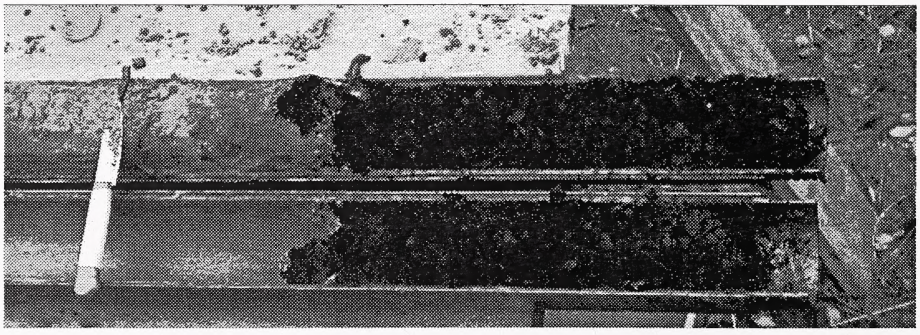


Figure 6. Coal in the hole east of Hondo.

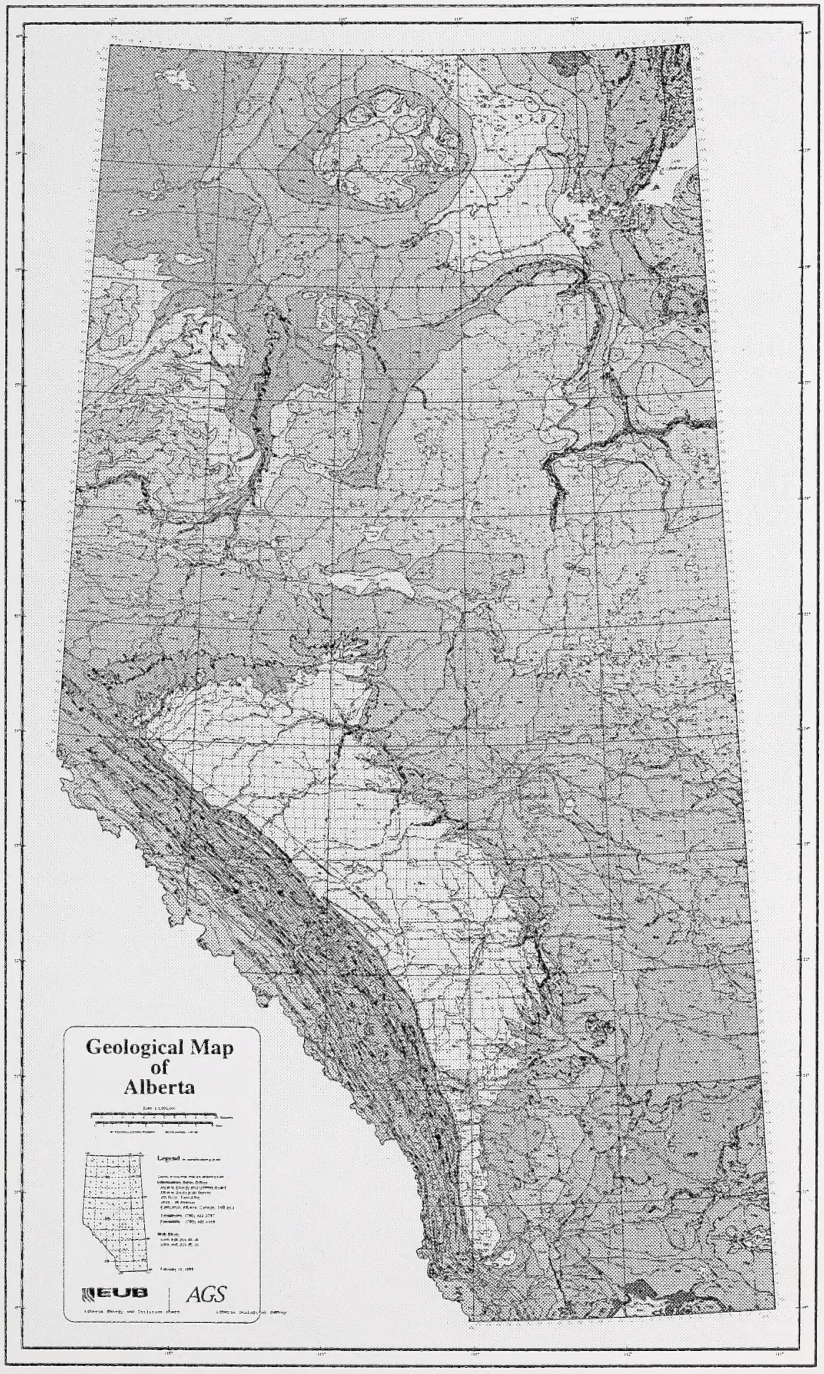
Story contact information

The following AGS staff may be contacted for further information on their articles:

Aggregate Database	Dixon Edwards	(780) 427-1516
Compilation PRA	Dinu Pana	(780) 422-2453
Diamond Potential	Roy Eccles	(780) 427-2671
Structural Kimberlites	Roy Eccles	(780) 427-2671
Surficial Mapping	Mark Fenton	(780) 427-1764

They may also be contacted via e-mail by entering the author's <first name.last name@gov.ab.ca>.

Geological Map of Alberta Now Available on CD-ROM with New Formats and Improved ArcView® Functions!



National Library of Canada
Bibliothèque nationale du Canada
3 3286 52797924 5

Newly Released Publications

Earth Sciences Reports

ESR 00-15D Quaternary Stratigraphy of the Buried Birch and Willow Bedrock Channels, Northeastern Alberta. PDF 4.19 MB document. $20.00

ESR 00-10 Geochemistry of Selected Glacial and Bedrock Geologic Units, Cold Lake Area, Alberta. PDF .47 MB document. $20.00

Geo-Note

GEO 00-01 Bedrock Topography, Drift Thickness, and Buried Channels, Northeast Alberta. PDF 13.07 MB document. No charge

Map

Map 237 Geological Map: Coal Valley Mapsheet NTS 83F/2. PDF 1.01 MB document. $20.00

Map 239 Surficial Geology of Wapiti Area, NTS 83L. PDF .71 MB document. $20.00

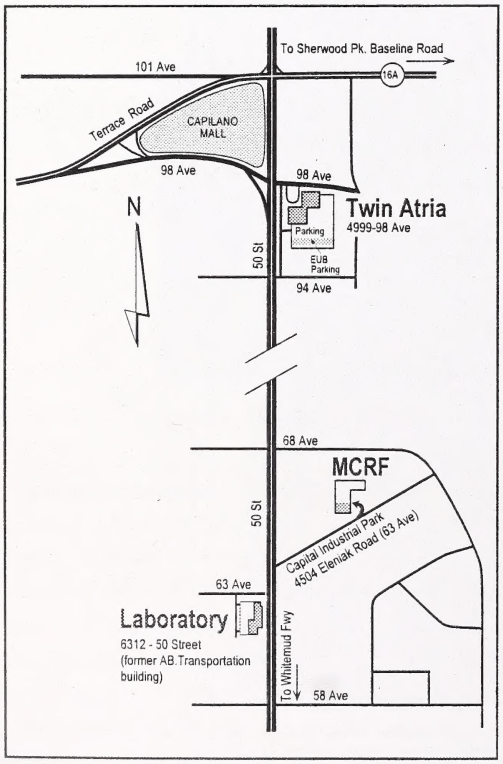
Come and see us at these conferences:

GAC/MAC Joint Annual Meeting

May 27-30, 2001
Memorial University
St. John's, Newfoundland
Commercial and University Exhibitors - 2nd Floor
Booth # T15

CSPG Annual Meeting

June 18-22, 2001
Telus Convention Centre
120 - 9th Avenue SE
Calgary, Alberta



AGS Locations

The main office of the Alberta Geological Survey is located at
4th Floor, Twin Atria Building
4999 - 98th Avenue
Edmonton, Alberta
Canada T6B 2X3
Phone: (780) 422-1927
Fax: (780) 422-1459

The Alberta Geological Survey Library is located at the address above and may be contacted at
Phone: (780) 427-4663
e-mail: <EUB.AGS-Library@gov.ab.ca>

Our mineral core facility (MCRF) is located at

4504 Eleniak Road
Edmonton, Alberta

For information on the MCRF or to book a visit, contact Rob Natyshen by phone at (780) 466-1779 or by e-mail at <Rob.Natyshen@gov.ab.ca>